OBSERVATIONS ON THE CHROMOSOME CYTOLOGY OF VELLOZIACEAE

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Abstract

Chromosome numbers of 15 species in four of the six genera of Velloziaceae were counted from root tip squashes. The family was previously known cytologically from a single count, although our preliminary findings have been reported elsewhere. The American Barbacenia *has* n = *17, while* Vellozia *has species with* n = *8 and 7. The African* Xerophyta *has* n = *24 in two species examined, and the monotypic* Talbotiopsis *has* n = *24, a count substantiating an earlier record of* n = *24–26. A base number of* x = *9 is proposed for Velloziaceae.* Barbacenia *appears to be a paleotetraploid genus,* Vellozia *a hypodiploid, and* Xerophyta *and* Talbotiopsis *are possibly paleohexaploids on the derived base of* n = *8.*

Velloziaceae are a small family of petaloid monocots comprising six genera, *Barbacenia* (102), *Barbaceniopsis* (3), *Nanuza* (1), and *Vellozia* (122) in South America, and *Xerophyta* (50) and *Talbotiopsis* (1) in sub-Saharan Africa, south Arabia, and Madagascar. Until recently, Velloziaceae were barely known cytologically, the only chromosome record being $n = 24$–26 for *Talbotiopsis elegans* (Stenar, 1925, as *Vellozia*). Attention was first drawn to the lack of cytological information for Velloziaceae by Ayensu (1973) in his extensive study of the family. In a review of cytological evolution in the angiosperms, Raven (1975) again focused attention on the scant cytological data for the family, stimulating this investigation. Preliminary findings, unfortunately inexact, were included in Raven's review. These and additional counts are presented here with corrections where necessary.

Materials and Methods

Plants for study were obtained from a live collection maintained at the Smithsonian Institution by Drs. L. B. Smith and E. S. Ayensu for their anatomical and taxonomic studies of the family. The material of *Xerophyta retinervis* was gathered in the wild by Goldblatt specifically for cytological study. Species examined are listed in Table 1 with collection data and chromosome numbers.

All counts were made from root tip mitoses. Roots were harvested from actively growing plants and pretreated in 0.003 M hydroxyquinoline for six hours at refrigerator temperatures. They were then fixed in 3 : 1 ethanol–acetic acid, hydrolyzed in 10% HCl for six minutes, and then squashed in lacto-propionic orcein.

Observations

Barbacenia

A diploid number of $2n = 34$ was found in each of four species of *Barbacenia* examined (Table 1). A preliminary count for this genus, $n = 16$ (Goldblatt in Raven, 1975), is incorrect. Chromosomes are all of similar size, 1–2.5 μm long, and are metacentric to submetacentric.

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TABLE 1. *Chromosome numbers in Velloziaceae. All counts are original except one for* Talbotiopsis, *for which a reference is given.*

Species	Haploid No. n	Collection Data
Barbacenia		
B. aff. *albiflora* L. B. Smith	17	Brazil. Minas Gerais: Biri-Biri, Mun. Diamantina, *Hatschbach 30183* (US).
B. coronata P. Ravenna	17	Brazil. Minas Gerais: Pico Itambe, *Hatschbach 30095* (US).
B. globata Goethart & Henrard	17	Brazil. Minas Gerais: Cons. Mata, *Hatschbach 30212* (US).
B. paranaensis L. B. Smith	17	Brazil. Parana: Fda. Morungaia, rio do Furil Mun. Senges, *Hatschbach 29212* (US).
Vellozia		
sect. *Radia*		
V. hirsuta Goethart & Henrard	7	Brazil. Minas Gerais: Diamantina, Serra do Espinhaco, *Smith & Ayensu 15999* (US).
V. riedeliana Goethart & Henrard	7	Brazil. Minas Gerais: 27 km W of Serro, *Smith & Ayensu 15983* (NY).
V. tubiflora (A. Rich.) Kunth	7	Brazil. Minas Gerais: Rio Itacambirucu, Grão-Mogol, *Hatschbach 41274* (US).
sect. *Vellozia*		
V. alata L. B. Smith	7	Brazil. Minas Gerais: 3 km N of Chapeado Sol. Serra do Ciop, *Smith & Ayensu 15951* (US).
V. bahiana L. B. Smith & Ayensu	8	Brazil. Bahia: exact locality unknown, *Maia s.n.* (US).
V. caruncularis Mart. ex Seubert	7	Brazil. Minas Gerais: 9 km W of Serro Cerrado, *Smith & Ayensu 15977* (US).
V. compacta Mart. ex Schultes f.	8	Brazil. Minas Gerais: 27 km W of Serro, *Smith & Ayensu 15986* (US).
V. pterocarpa L. B. Smith & Ayensu	8	Brazil. Minas Gerais: Diamantina, *Hatschbach & Ahumada 31705* (US).
Xerophyta		
X. humilis (Baker) Dur. & Schinz	24	South Africa, without precise locality, *Gaff s.n.*, no voucher.
X. retinervis Baker	24	South Africa: Pretoria, hills at Bot. Res. Inst., *Goldblatt s.n.*, no voucher.
Talbotiopsis		
T. elegans (Hook. f.) L. B. Smith	24	South Africa: exact locality unknown, *Meyer s.n.* (NA).
	24–26	Stenar, 1925.

Vellozia

The preliminary count (Goldblatt in Raven, 1975) for the genus, $n = 9$, was not confirmed by further examination. Species of *Vellozia* sect. *Radia* have $2n = 14$, while $2n = 16$ and 14 were found in species of sect. *Vellozia*. A third section, *Xerophytoides*, is so far uncounted. The chromosomes are comparable in size and appearance to those of *Barbacenia*. In some preparations two diffuse, lightly staining areas stand out. The significance of these shadowy chromatic bodies is unclear, but they do not seem to be chromosomes.

Xerophyta

A diploid number of $2n = 48$ was found in the two species of this Afro-Madagascan genus counted, *Xerophyta humilis* and *X. retinervis*. Chromosomes are generally similar in size and appearance to those of *Barbacenia*, and 1–2 μm long.

Talbotiopsis

One collection of this monotypic genus, renamed *Talbotiopsis* (= *Talbotia*) by Smith (1985), was examined. Our count, $2n = 48$, substantiates Stenar's (1925) report of $n = 24$–26 for *T. elegans* (published under the synonym *Vellozia elegans*). Chromosomes of *Talbotiopsis* are similar to those of *Xerophyta*.

Discussion

The chromosome data presented can only be regarded as preliminary for Velloziaceae, given that we now have counts for just 15 species in four genera out of a total of 250 species in six genera. Nevertheless, the available counts are fairly consistent within genera and so suggest that they comprise a representative sample of the chromosome variation in Velloziaceae.

The counts suggest the following hypothesis of cytological evolution. First, base number may be $x = 9$ for Velloziaceae. It follows that the number $n = 17$ in *Barbacenia* would represent aneuploid reduction from a paleotetraploid base of $n = 18$. The numbers $n = 8$ and 7 in *Vellozia* are then interpreted as aneuploid on the family base of $n = 9$. *Xerophyta* and *Talbotiopis* appear to be paleohexaploids derived from the secondary base of $x = 8$. The shared number in *Xerophyta* and *Talbotiopsis* supports the current belief (Ayensu, 1973) that these two African genera are more closely allied to one another than to the other genera of the family, all South American. Other scenarios can be constructed, but the one outlined seems to us the most parsimonious, and thus recommended at least in the light of current knowledge of Velloziaceae and the patterns of numerical chromosome change that occur in plants (Raven, 1975; Goldblatt, 1980). A base number of $x = 8$ for Velloziaceae appears at first to be a more parsimonious interpretation, with polyploid doubling (to $n = 16$) and subsequent aneuploid increase to achieve $n = 17$ in *Barbacenia*. However, given that ascending aneuploidy is at least four times less common in the flowering plants than descending aneuploidy, we think the latter possibility is less likely, although not implausible.

The chromosome numbers in Velloziaceae tell us little about possible relationships of the family. The most critical current phylogenetic opinion (Dahlgren et al., 1985) treats Velloziaceae as the sole family of Velloziales, one of six single family orders comprising Bromeliiflorae. The reasons for removing Velloziaceae from Liliiflorae and Liliales, to which the family is traditionally assigned, include the *Strelitzia*-like epicuticular waxes, copious starchy endosperm, and stomata with subsidiary cells (Dahlgren et al., 1985). All of these apparently fundamental features correspond with other families of Bromeliiflorae and conflict with Liliiflorae.

Base number in the Bromeliaceae, the family and order possibly closest to Velloziaceae, is $x = 25$ (Raven, 1975), which contrasts sharply with the suggested $x = 9$ in Velloziaceae. Cytology thus appears to contribute little to our understanding of relationships of the families of Bromeliiflorae. However, there seems reason to suppose that if Bromeliiflorae sensu Dahlgren et al. do constitute a natural alliance, then $x = 9$ or 8 are important base numbers. Other orders of Bromeliiflorae include Philydrales (Philydraceae, $x = 9$ or 8), Haemodorales (Haemodoraceae, possibly $x = 8$), and Pontederiales (Pontederiaceae, $x = 8$) (base numbers from Goldblatt, 1980). The last order included in Bromeliiflorae by Dahlgren et al., Typhales, with $x = 15$, is very different and may even be misplaced here.

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